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BREEDING RUST RESISTANT VARIETIES OF WHEAT

MILLIPEDES DAMAGE CROPS

INCIDENCE OF GALL-FLY ON PADDY

OPTIMUM SPACING AND ECONOMIC SEEDRATE FOR GROUNDNUT CROP

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CONTENTS

PAGE

EDITORIAL

Integrated Crop Production 125

RESEARCH ARTICLES

Breeding Rust Resistant Varieties of Wheat for Northern Districts of Mysore State—By B. H. KATARAKI AND A. L. BANAHATTI 127

Millipedes Damage Crops—By DR. M. PUTTARUDRIAH .. 130

Induction of Fertility in Genetically Self-Incompatible Material of Crotalaria juncea—By C. KEMPANNA 133

Studies on the Incidence of Gall-Fly on Paddy—By M. K. GANESH PAI AND K. HANUMANTHA RAO 136

Hand-Operated Mechanical Drill for Sowing Jowar—By S. V. PATIL, M. B. TIPPANNAVAR AND M. A. MIRAJKAR 139

Parasites and Predators of Some of the Common Insect Pests of Sugarcane in Visvesvaraya Canal Tract, Mandya District, Mysore State—By K. S. SHIVASHANKARA SASTRY AND M. APPANNA 143

Optimum Spacing and Economic Seedrate for Groundnut Crop in the Arid Zone of Northern Karnatak—By N. B. KAJJARI, I. R. MORABAD, M. S. SALANKI AND F. B. KURTHKOTI 154

GENERAL AND REVIEW ARTICLES

New Varieties of Fruit Plants in Coorg—By DR. K. M. AIYAPPA AND P. P. NANJAPPA 160

Gibberellin—A New Phytohormone—By D. V. MURTHY .. 162

Citrus Canker—Xanthomonas citri (*Hasse*) *Dowson*—By DR. K.M. AIYAPPA 164

ABSTRACTS

Plant Breeding and Genetics 168

Agricultural Chemistry 171

Entomology 172

Agronomy 176

RESEARCH IN PROGRESS 178

Editorial

INTEGRATED CROP PRODUCTION

Crop production is a continuous and integrated process involving many aspects and increased production is a result of an improvement in one or more aspects of crop growing. Similarly, agricultural research is a continuous process, but it is carried out by different specialists on different aspects. Agronomists work on the various aspects like, tillage, fertilisers and rotational requirement of crops, while Pathologists on the control of diseases, Entomologists on the control of pests, Botanists on the improvement of varieties and the Chemists on the nutritional aspects and so on. Each specialist contributes to the improvement of the crop production on particular but different aspects. All these years many individual items of recommendations have been given out for adoption to ryots after testing the same for their adaptability in different regions. Attempts have been made by the Agricultural Extension Officers to demonstrate and advocate these individual items of improvements of crops independently. While research work has to be done in parts on different aspects of crop production independently, recommendation to farmers, however, has to be in the form of an integrated whole to obtain the best results.

No concentrated efforts have been put in any time to popularise improved methods of raising different crops formulated by integrating all the available recommendations of specialists on different aspects, probably with the exception in the case of Japanese Method of Paddy Cultivation. Similar attempts are now being made in the nation-wide *Rabi* Campaign which has been launched recently. It has been shown beyond doubt that the benefits that are likely to accrue by adopting integrated method would be more than sum total of benefits that accrue from isolated individual recommendations. For instance, using only improved varieties or only application of fertilisers would result in certain amount of increased production, say (*a*) or (*b*). But when both the practices, *i.e.*, improved varieties as well as application of fertilisers are adopted together then the increased production is likely to be more than (*a*) *plus* (*b*). Improved varieties might be having inherent capacity to grow well and yield more but for want of sufficient supply of nutrients the capacity would not be fully exhibited. Similarly, application of heavy dosages of fertilisers to varieties inherently incapable of producing more will be a wastage.

It can therefore be said that time is ripe to formulate improved methods of growing each and every crop by integrating all the available

recommendations and popularise the same by laying out half-field demonstration trials on cultivators' plots. It would go a long way in popularising these methods if every member of the Farmers' Forum and the Young Farmers' Association and Gram Sahayaks trained in Village Leaders' Training Camps raise their own crops by adopting these methods and induce their neighbours also to adopt similar methods. This will also give an opportunity for the research workers to know in what aspects sufficient work has not been done and therefore needs intensification of investigations.

Research Articles

BREEDING RUST RESISTANT VARIETIES OF WHEAT FOR NORTHERN DISTRICTS OF MYSORE STATE

By B. H. Kataraki[1] and A. L. Banahatti[2]

Introduction

Wheat is one of the important cereal crops in the northern districts of Mysore State, occupying an area of 5–6 lakhs of acres, out of which about 5% is taken under irrigation while the rest is taken as dry crop. *Durum* wheat varieties like *Jaya*, *Local Red* wheats are under cultivation in these parts. Wheat cultivation is mainly confined to the eastern taluks of Dharwar and Belgaum Districts and the whole of Bijapur District.

Soils and Climate

The soils generally adopted for wheat cultivation in these areas, vary from deep black to medium black soils. Wheat, being salt-tolerant to a certain extent, is also taken up in *Karl* soil. The annual rainfall varies from 18″–24″ with heavy showers usually received during the months of September and October. The maximum temperature in May is never more than 105° F. while the minimum temperature recorded during December hardly touches below 42° F.

Problems of Wheat Cultivation

Rust being the limiting factor in the cultivation of wheat, varies from year to year in its severity of infection, being controlled by weather conditions. It causes enormous losses in certain seasons, when weather conditions favour heavy infection. Loss is due to reduction in number and size of seed, while the production of small shrunken seeds of inferior quality seriously affects the market value of the grains. During certain seasons, of very heavy infection, the entire crop is lost.

Types of Rust

Wheat is attacked by three types of rust namely:—

(i) Black stem rust (*Puccinia graminis tritici*) (Pers.) Eriks and Henn,

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[1, 2] Agricultural Officers, Agricultural Station, Annigeri.

(ii) Brown or leaf rust (*Puccinia triticina*) Eriks and

(iii) Yellow or stripe rust (*Puccinia glumarum*) (Schm., Eriks and Henn).

Mainly, the black stem rust causes heavy losses in yield and quality of wheat in these parts. Yellow and Brown rusts though they appear in certain seasons do not cause much loss in grain yield. There are twelve physiological races observed so far in India in the Black stem rust. Out of three species of wheat under cultivation in India, *durums* suffer heavily due to Black stem rust. Only *durum* varieties being under cultivation in these parts and as they face serious danger from Black stem rust, attempts to breed rust resistant *durum* wheat varieties for this tract were started at the Agricultural Research Station, Annigeri, in 1947.

Method of Testing Wheat Varieties and Synthetic Material for Rust Reaction

Facilities have been provided for the plant breeders for testing their material for rust reaction at Mahabaleswar in Bombay State since 1942. The eleven types of prevalent physiological races, *viz.*, 15, 21, 24, 34, 40, 42, 42 A, 42 B, 75 and New race A and New race B, have been maintained in a glass-house at Mahabaleswar, on the variety N P–4 which is susceptible to all these races. The temperature of the glass-house is never allowed to rise beyond 80° F., as higher temperature does not favour infection.

Standard wheat varieties are tested for all these types of physiological races separately in seedling stage under the glass-house conditions and in adult stage with a mixture of all these races in the plots. Hybrid material is tested in mature plant stage only in plots, where selections are made for rust resistance. Conditions for heavy infection of rust in plots are maintained by growing highly susceptible varieties round these plots and infection is induced by spraying a water suspension of uredospores of all these races of rust. Infection on the border rows increases within a few days and thereby transmitted to the plots by air currents. Water suspension of these uredospores is also sprayed on the material under test. Optimum humidity is also maintained in these plots by flooding or spraying the plots, and enclosing these plots with thick cloth and sprayed with water at suitable intervals. These steps bring in heavy artificial infection of rust. The selections made at Mahabaleswar under such conditions of heavy infection, as resistant, will be grown in the subsequent season at Annigeri which will again be subjected to selection for economic and agronomic characters. This process is continued year after year till homozygosity for all the desired characters, including rust resistance, is reached.

Review of Research Work Done at Agricultural Research Station, Annigeri

Since the inception of the Cereal Breeding Station at Annigeri in 1947, several local bulks and outside collections in wheat were studied and subjected to intensive selection. As a result, high yielding selections were isolated from the locals in the year 1949, but they were found equally susceptible to black stem rust. Outside collections coming from *vulgare* and *dicoccum* species, could not be acclimatised. Hence, to induce rust resistance in the high yielding local selections they were crossed with *Gaza*, the only rust-resistant *durum* wheat obtained from Canada in the year 1949. The advantage of *Kharif* season, to study two generations of the above synthetic material in a year, was taken with a view to expedite the work. Several rust-resistant progenies have been isolated from some of these crosses which run from F 10 to F 11 generations. The yield and quality of these rust-resistant progenies are equal to local bulk and they are nearing homozygosity for all the important economic and agronomic characteristics.

The cultures 241–46 from (B × *Gaza*) F 12 and 160–68 and 185 (G × 40) F 11 are highly rust-resistant types which combine all the desirable economic characters. The per acre yield of these types is however slightly but not significantly lower than the local strains in non-rust years. But in rust epidemic years, as observed during 1956–57, these improved resistant progenies yield much better with fully developed grains, while the local bulk yield very low with very shrivelled grains. These progencies in addition to few more strains are expected to be given out to the districts for further trials from the ensuing season.

Gaza is the only *durum* variety which serves as an important source to introduce high resistance to rust in the local wheat varieties of this tract. As *Gaza* is low yielder under our conditions, having undesirable spottedness of grains, it is proposed to explore foreign countries like U.S.A., Australia and Russia for new rust resistant *durum* varieties for creating fresh synthetic material for further exploitation.

(Received: 7th August 1958)

MILLIPEDES DAMAGE CROPS

By Dr. M. Puttarudriah*

Introduction

Millipedes are non-insects, commonly called thousand-legged worms. They are long, worm-like, cylindrical, dark-brown, many segmented with two pairs of legs to each of the segments except the first four behind the head. They are familiarly seen in field and garden crawling on the soil and under the bark of trees. When disturbed they characteristically coil themselves like a spring. The head bears a pair of short antennæ and biting mouth parts. A thousand species have been described and most of them live in moist soil, heaps of leafmould, and rotting logs. In general they are known to feed on decaying vegetable matter and manure; but a few are responsible for some damage to growing crops.

Review of Literature

They have been known to attack garden crops like lettuce, cabbage, potatoes, dahlias, corn, parsnips, carrots, beets, turnips, radishes, cauliflower, beans, peas, tomatoes, melons, and cucumbers, feeding on the underground parts of plants, tunnelling into root vegetables, eating the planted seeds, devouring leaves and boring into fruits in contact with the ground (Essig 1926, Metcalf and Flint, 1928).

In India they have been found damaging roots of vegetables and underground parts of groundnut in some areas (Fletcher, 1914; Ramakrishna Ayyar, 1940). But they have never assumed serious proportions necessitating control measures in any part of the world.

In Mysore though they are commonly seen crawling on the bunds in some fields and in plantations and gardens their number has always been negligible and their damage to crops insignificant.

Present Observations

However during 1957 and 1958 in the months of June-July, they were seen in alarming numbers injuring many field crops near Jagalur in Chitaldrug District. At the time of their occurrence during both the years, the atmospheric conditions were cloudy, windy with occasional rains. The fields were damp. The millipedes were found to be dark-brown, about $2\frac{1}{2}$–3″ long and 0·2″ thick, crawling in large numbers on the surface; and had caused severe damage to chilly and cotton

* Government Entomologist, Department of Agriculture, Bangalore.

seedlings. They also attacked other plants like coriander, blackgram, wild brinjal and Ipomea weeds in the fields. They had cut the chilly stems and nibbled cotton cotyledonous leaves. They were found to twist themselves along stems of chillies, and coriander, and bite margins of leaves holding the same between the front legs, while the jaws worked (Photos). They fed voraciously on onions exposed from the soil and on chilly stems. They were seen also on tender jowar plants but no damage to them could be made out. In the laboratory they fed on pumpkin and sweetpotato leaves. Observations at Jagalur revealed that they were active during cooler hours, shunning the bright sun by moving into shady places. A large number of them had taken shelter along the cracks of bark and crevices of neem, banni (*Acacia* sp.) trees found here and there in the fields and on pongamia, *Cassia* sp., and other wild plants along the bunds. They were particularly serious at one village—Marenahalli, on chillies.

Life-History

The females are known to lay 60–100 or more eggs during May-July in an earthern nest in the soil. After an incubation period of 10–14 days the young millipedes come out resembling the adults except for size, number of segments and legs which increases with growth.

Control

Broadcasting lime over the surface and working it into the soil would lessen their number. A handful of soot dissolved in half a gallon of water and poured around the bases of plants would drive them away. Cabbage leaves soaked in Paris Green and kept as bait in a number of places in the field would attract them and kill them (Theobald, 1904).

At Jagalur hand collection of them was found to be easy, cheap and effective. During 1957 in one field the owner had arranged with the labourers who collected nearly a thousand of them. The moment they are touched they coiled themselves and could be easily picked up and gathered in a bag or tin. Finally they could be killed by dumping into kerosened water in a tub. If owners of fields can induce the labourers and boys with a small payment of about two or three annas for every 100 of them, they would certainly collect them earnestly. Instead of taking up control measures with toxic insecticides, the hand collection appears to be the easiest and best.

In nature they are said to be preyed upon by a *Reduviid* bug, *Physorhynchus* sp., but appear to be more exempt from any predators and parasites. They also defend themselves by emitting an offensive odour.

As can be made out from a review of literature and experience at Jagalur, millipedes appear to be potential pests on a large variety of field and garden crops. If left unchecked in the beginning, they would multiply enormously and spread everywhere. So wherever they are found the growers must kill them.

The species involved is being identified and detailed studies including life-history of this pest will be published later.

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Blackgram and cotton seedlings fed upon by millipedes

Millipedes on chilly stems and feeding on the leaves

Coriander fed upon by millipedes

INDUCTION OF FERTILITY IN GENETICALLY SELF-INCOMPATIBLE MATERIAL OF *CROTALARIA JUNCEA*

By C. Kempanna*

Introduction

Production of pure seed and maintenance of purity without deterioration for a considerable period is a prime factor in crop improvement. This is accomplished in nature both in auto and allogamous species by self-pollination. But, in the latter case, success of producing homozygous seed by selfing, sometimes, is remote and entails considerable difficulty in developing new varieties of crops. Of the main causes, responsible for failure of seed setting by self-pollination in such species, the operation of " self-incompatibility " mechanism is one, which induces retardation in the growth of the pollen tube in the style and prevents fertilization before the flower abscises. Acceleration of the growth of the pollen tube to effect fertilization in time by ordinary means is a difficult task. Reports have shown the possibility of obviating this difficulty by certain methods in self-sterile *petunias*, marigolds (*Tagetes erecta*), cabbage, (*Brassica oleracea*), red clover (*Trifolium pratense*) and *Nicotiana* (Eyster, 1941; Avery *et al.*, 1947; Riley, 1949) and, therefore, an attempt has been made to induce fertility in self-incompatible species *Crotalaria juncea*, Linn. which is an important green manure crop.

Material and Methods

The seeds of *Crotalaria juncea*, Linn. collected from Hebbal were sown in the garden of the Agricultural College, Hebbal, Bangalore, during early part of 1958. The plants were observed to be self-incompatible. The methods employed were: (1) Self-pollination by hand; (2) Bud pollination, two days earlier to anthesis; (3) Cutting of the stigma and pollination; (4) Washing the stigmal well with distilled water before pollination; (5) Application of hormone to the stigma and ovary. The hormones used were *Indole acetic acid* and *Indole butyric acid*. Aqueous solutions of these substances were prepared at 0·01% and 0·001% concentration and applied to the stigma and ovary through a piece of cotton lint dipped in these solutions. The moist cotton was allowed to remain round the ovary. The pollen

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dust from the same flower or from different flowers of the same plant was applied to the stigma and flowers were protected by paper bags. The normal healthy flowers were selected for each treatment. The styles were fixed in 1 : 3 acetic alcohol, softened in 1/N HCl at 60° C. for half an hour and squashed in cotton blue for pollen tube studies. The experiment was repeated to confirm the results.

Experimental Results

In all the treatments, except the hormonal treatment, the flowers withered and dropped off four or five days after pollination without producing any fruits. On squashing the pollen tubes from these treatments, it was found that the growth of the pollen tubes was very much retarded as compared with those of the control under open pollination. In the hormone treatment, particularly in *Indole butyric acid* at 0·01% concentration, the formation of fruit was observed but, the other concentration of 0·001% of this chemical and two concentrations of Indole acetic acid failed to produce fruits. Out of ten flowers treated with *Indole butyric acid* at 0·01% concentration, five flowers developed into pods and all these five pods produced viable seeds subsequently. This indicates the possibility of producing seeds on self-pollination by the application of hormones.

Discussion

Self-sterility was recognised both in plants and animals as long back as 18th century and reported for the first time in plants in 1764 by Koelreuter and by Castle in 1896 in animals. Since then the trials by various workers to overcome the difficulty of producing selfed seed in such species were afoot. Bud pollination, two to three days earlier to anthesis, was found to be successful in inducing fertility in *Nicotiana* (Riley, 1949). In this method, the pollen tube gets more time to grow and reach the ovary for fertilization before the abscission of the flower. In addition to bud pollination, cutting of the stigma and applying pollen to the cut end of the style and washing the stigma well with distilled water before pollination is being practised in *Brassica*, inasmuch as these treatments seem to aid to get rid off the inhibitory factors that would probably be present and inhibit the growth of the pollen tube in the stylar tissue. These inhibitory factors are supposed to have developed due to the operation of self-sterile mechanism. Application of hormones in the form of paste or solution to the stigma and ovary was reported to be fruitful in *petunias* by Eyster (1941); in cabbage (*Brassica oleracea*), marigolds (*Tagetes erecta*), red clover (*Trifolium prateuse*), etc., by Avery *et al.* (1947). In the present material, bud pollination, cutting of the stigma and washing the stigma with distilled water were met with no success as setting was not noticed under any

one of these treatments. On the other hand, application of hormonal solution, particularly *Indole butyric acid* in 0·01% concentration, was able to produce fruits with viable seeds by, perhaps, counteracting the effect of inhibitory factors, developed in the style, which would have otherwise induced failure of fertilization.

Summary

1. Attempt has been made to induce fertility in the self-incompatible species *Crotalaria juncea*, Linn., which is a common green manure plant.

2. The fertilization did not occur under bud pollination, pollination after cutting of the stigma and pollination after washing the stigma with distilled water.

3. Setting of fruits with viable seeds was noticed under hormonal treatment with *Indole butyric acid* at 0·01% concentration. This is supposed to have been due to the counteraction of the effect of the inhibitory factors deveopled in the style, on account of the operation of self-incompatibility mechanism.

Acknowledgement

I am thankful to Sri. B. Venkoba Rao, Principal, Agricultural College, for his help in providing the facilities and suggestions. I am also grateful to Sri. T. Sreenivasa Murthy, Government Economic Botanist, for his suggestions and going through the manuscript.

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STUDIES ON THE INCIDENCE OF GALL-FLY ON PADDY

By M. K. Ganesh Pai[1] and K. Hanumantha Rao[2]

Introduction

The gall-fly (*Pachydiplosis oryzæ*) though commonly found as a minor pest on paddy, at times assumes serious proportions causing heavy loss. It occurs mostly on the first crop paddy (March-April to September-October), seldom on the second crop paddy (September-October to January-February) and never in the third crop (February-March to May) in South Kanara District. The damage is caused by the maggot of the fly. The fly lays eggs on the plant and sometimes on the standing water and the maggots on hatching eat into the young shoots and as a result of the irritation caused, in the place of the normal stem, a hollow cylindrical gall is formed with a green tip. The colour of the gall may be silvery white, pink or purple, depending upon the varieties. The entire larval and pupal period of *Pachydiplosis oryzæ* is spent in the gall itself. When ready to emerge the late instar larva works its way up to the tip of the gall. The emergence hole is bored and the adult fly makes its way out. The gall then gradually dries up.

The estimation of loss due to this insect pest is very complex (Murthy, 1957). Ordinarily, in case of mild attack, the crop may recoup by fresh tillering. If, however, the fresh tillers are also attacked there is bound to be a great loss in yield of grain, amounting to more than 60%. Such an incidence was noticed in the year 1954 at the Paddy Breeding Station, Mangalore and hence the study discussed below was taken up.

Materials and Methods

The sowing period for paddy in South Kanara ranges from third week of March to the second week of May and the normal planting season is the second and third week of June. Because of the system of raising only dry nurseries for the first crop the seedlings do not get noded even if they are 2–3 months old. The gall-fly incidence is found to occur in all popular varieties of paddy irrespective of the time of sowing and planting and in all types of soil and water conditions. With a view (i) to study the differential response of the pest attack due to the time of planting and (ii) to find out the response due to the effects of varying soil and water conditions, observational trials in two series were laid

[1, 2] Paddy Breeding Station, Mangalore (South Kanara District).

out during the first crop seasons of 1955–56, 1956–57 and 1957–58. The first series was the time of planting series and consisted of planting seven popular varieties, *viz.*, MGL. 1, MGL. 2, MGL. 3, MGL. 4, MGL. 5. MTU. 3, and PTB. 9 in the first week of June (early planting), middle of June (normal planting) and first week of July (late planting). All the three batches were planted in one plot under similar type of soil and water conditions, and counts of incidence were recorded at weekly intervals starting from the first week after planting till the crop was in 'Flag-Leaf'. The second series to find out the effect of varying soil and water conditions on the pest incidence consisted of planting the above varieties under three soil and water conditions, *viz.*, (*a*) high level with good drainage, (*b*) low level with good drainage and (*c*) ill-drained plots. The nurseries of the three batches were sown on the same date and counts of incidence were recorded as in the first series.

Results

In the first year of the trial it was observed that the incidence was least in the late planted batch which is quite against the popular belief

Table showing the differential responses of gall-fly incidence

Average percentage incidence of the pest

(*a*) Time of planting

S.No.	Time of planting	1955–56	1956–57	1957–58
1	Early planting ..	8·5	17·7	4·6
2	Normal planting ..	9·5	14·2	4·8
3	Late planting ..	5·5	10·4	7·4

(*b*) Varying soil and water conditions

S.No.	Particulars	1955–56	1956–57	1957–58
1	High level well-drained soil ..	6·2	14·9	5·6
2	Low level well-drained soil ..	3·4	14·7	6·6
3	Ill-drained soil ..	12·0	8·4	4·1

(*c*) Varieties

S.No.	Variety	1955–56	1956–57	1957–58
1	MGL. 1 *Guddubolliari* ..	7·8	13·2	5·5
2	MGL. 2 *Red Kayama* ..	8·8	14·4	5·2
3	MGL. 3 *Halluga* ..	9·6	13·8	6·4
4	MGL. 4 *Kanwa* ..	11·5	17·0	7·4
5	MGL. 5 *Mascathy* ..	5·8	7·6	3·4
6	MTU. 3 *Potti Basangi* ..	13·2	13·8	7·2
7	PTB. 9 *Thawala Kannan* ..	10·8	13·9	5·5

that late planting induces gall-fly attack. In the soil and water series it was observed that ill-drained conditions favoured the incidence. It was generally observed that incidence was to a certain extent directly proportional to tillering and that the strain MGL. 5 is comparatively resistant to the gall-midge attack. In the second year of the trial it was observed again that the incidence was comparatively lowered in the late planted batch but in the soil and water series it was observed that the ill-drained soil conditions recorded the least incidence. For the second year also it was observed that incidence was to a certain extent directly proportional to tillering and that the strain MGL. 5 was comparatively resistant to the attack. In the third year of the trial it was observed that the incidence was highest in the late planted batch and in the soil and water series the ill-drained soil recorded the least incidence and again it was observed that incidence was to a certain extent directly proportional to the tillering and that strain MGL. 5 was comparatively resistant to the incidence.

Conclusions

The trials conducted during the past three years indicate that (i) strain MGL. 5 (*Mascathy*) is comparatively resistant to the gall-fly attack, and (ii) time of sowing and planting the first seasonal crop or varying soil and water conditions does not seem to have any influence on the pest incidence under South Kanara conditions of paddy growing.

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HAND-OPERATED MECHANICAL DRILL FOR SOWING JOWAR

By S. V. Patil,[1] M. B. Tippannavar[2] and M. A. Mirajkar[3]

Introduction

Proper sowing is an important operation in the successful production of Jowar crop. The seeds have to be sown uniformly in order to establish better stand and too much overcrowdedness and gapiness at places will reduce the yields considerably. Jowar sowing is, therefore, usually done by experienced persons with the help of a drill. Still then, it is not possible to regulate the spacing in a line.

With hand dibbling, however, it is possible to regulate the spacing both ways. It has been found that dibbling of Jowar also gives higher yields than sowing with drill. But, however, dibbling on large scale is not practicable because of time involved as well as labour and cost. A mechanical drill which can regulate the spacing in a line is a long-felt need of our cultivators. There are of course many mechanical drills, on the market, but they are complicated in design, costly and usually of foreign make, not so well suited to our conditions. Thus, these drills have remained beyond the reach of our ordinary farmers. In order to overtake this difficulty at the Agricultural College, Dharwar, a simple and useful mechanical drill has been designed for sowing Jowar, the details of which are given below.

Construction

The implement consists of an ordinary seed-drill excepting that instead of tubes and seedbowl, a seedbox is mounted on the headpiece with the help of an iron stand. In the seedbox is inserted an axle. On the axle three discs are fixed. At the periphery of the disc, spoons are fixed at equal distances similar to the ones provided in the Agricultural Engineer's drill. The size of the spoon is such that it will hold 2–3 Jowar seeds at a time. The number of spoons and size of spoons could vary depending upon the seed-rate and spacing in a line required. For sowing Jowar for grain two spoons on each disc are fixed, A seed-cup is fixed near each disc to receive the seeds dropped in by the spoons. Each seed-cup is connected to a coulter with the help of small galvanised iron tubes and second-hand cycle rubber tube. On the right side of the box a handle is fixed on the axle for rotating the discs (Figs. 1 and 2

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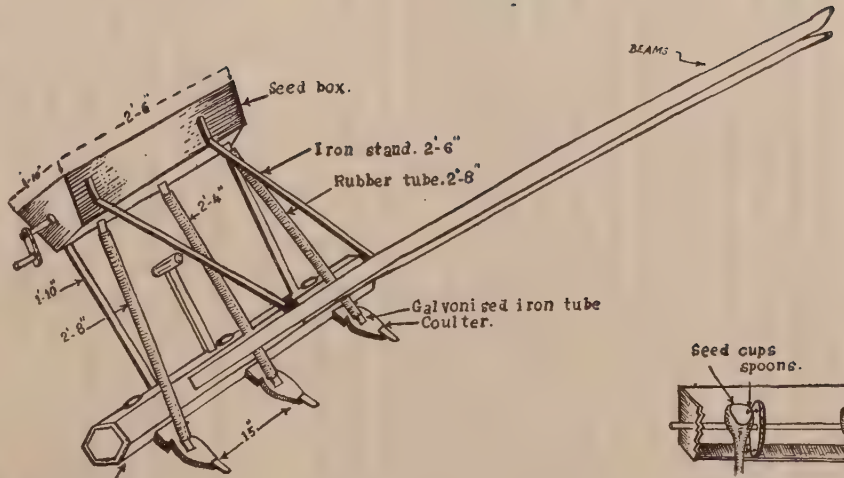

Fig. 1. Hand operated mechanical seed drill.

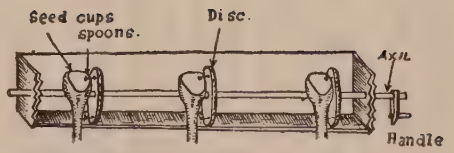

Fig. 2. Internal arrangement in the seed box.

for construction). The cost of getting prepared one such three coultered mechanic drill is given below:—

COST OF THE IMPLEMENT

(*a*) *Drill*:

		Rs. NP.
1.	Cost of Babul wood 60″×8″×5″ for headpiece ..	7·00
2.	Cost of 2 teak poles each 10′ long and 3″ in diameter for beams	5·00
3.	Handle with grip	0·50
4.	Cost of Dindal Wood for 3 coulters	1·00
5.	Cost of 12″ long flat iron (1″×¼″) for coulter tynes ..	1·00
6.	Wages of carpenter for one day	4·00
7.	Wages of Blacksmith for ¼day	1·00
8.	Wages of labour to assist the carpenter and smith, for one day	1·00
9.	Charcoal for iron work	0·50
	TOTAL ..	21·00

(*b*) *Seedbox and Stand:*

1.	Cost of Devadhari planks for seedbox	2·00
2.	Iron rod 5/8″ round 3′–6″ long for axle	3·00
3.	Cost of 3 iron discs 4″ in diameter and 1/8″ thick ..	1·50
4.	Cost of 3 flanges for fixing the discs	6·00
5.	Cost of 6 feeding spoons	6·00
6.	Cost of 3 seed-cups of brass	12·00
7.	Cost of iron (1″×¼″) flat, 10′ long for seedbox stand to secure the seedbox	3·50
8.	Nuts and bolts of 3/8″ size—12 Nos.	3·00
9.	Second-hand cycle tube for seed tubes	0·50
10.	Charcoal for smithy works	0·50
11.	Wages of carpenter for one day	4·00
12.	Wages of Blacksmith for ¼ day	1·00
13.	Wages of labour to assist the carpenter and smith, for one day	1·00
	TOTAL ..	44·00
	Total cost of the implement	65·00

Working

The selected and sieved seeds of Jowar are put in the box. The box is filled with seeds upto a height of 2″ taking care to see that the seeds are well below the brim of the funnel. The bullocks are harnessed to the implement as usual and as the implement is pulled forward, the handle is turned slowly with a steady speed. As the handle is turned the discs rotate, the spoons pick up 2–3 Jowar seeds at a time and drop them in the funnel. The seeds dropped in the seed-cup are carried to small furrows opened by the coulters. Thus, the seeds could be dropped in a line at slightly more or less regulated spacing. When two spoons are mounted on the disc having 4″ diameter, the seeds are dropped with 8–12″ spacing in a line. It is not possible to drop the seeds exactly at a particular spacing, as the speed of the bullocks and the speed with which handle is turned would vary a little. For all practical purposes even if the seeds are dropped with this much variation, it would considerably help to avoid overcrowdedness and gappiness at places in the field. Preliminary small-scale trials have been taken with the drill and the results indicate that the device may prove to be a better implement for sowing than the ordinary drill, where sowing has to be done by hand.

Conclusion

The implement described above is simple in design and can be got prepared with the help of local artisans. With this drill, it is possible to sow the seeds more uniformly. Spacing in a line can be regulated to a great extent. However, it may not be possible to regulate the spacing exactly in a line. This could have been done, if a wheel is provided and power is taken off from the wheel rotating the axle. But, when wheel is provided considerable difficulty is encountered in smooth working of the implement in the field. However, further work in this direction is in progress. In the meantime, it is worthwhile for our progressive cultivations to get one such implement prepared and try for sowing Jowar with slight modifications here and there if found necessary. Using different size spoons the implement can also be used for sowing paddy and cotton.

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FIG. 3. Hand-operated seed drill in operation

PARASITES AND PREDATORS OF SOME OF THE COMMON INSECT PESTS OF SUGARCANE IN VISVESVARAYA CANAL TRACT, MANDYA DISTRICT MYSORE STATE

By K. S. Shivashankara Sastry[1] and M. Appanna[2]

Introduction

Sugarcane, an important cash and food crop, is subject to the attack of several insects. Gupta (1954) and Gupta and Avasthy (1956) have published a list and a review of work done on parasites and predators of sugarcane insects in some parts of our country wherein the co-ordinated scheme for researches on insect pests of sugarcane is in progress. This note is intended to furnish the data on some of the parasites and predators of sugarcane pests as recorded in the Visvesvaraya Canal Tract, Mysore State, during 1949–55.

1. Order: HYMENOPTERA

(A) Family: *Braconidae*

1. *Microbracon chinensis* Szepligeti.—A larval parasite of *Chilotræa infuscatella* Snellen—this occurs generally during July-August, but is not very common. Its other hosts include *Sesamia inferens* Walker; *Proceras indicus* Kapur, on cane (Usman, 1950).

2. *Microbracon hebetor* Say.—This has been observed to parasitise naked as well as enclosed larvæ of the shoot borer *C. infuscatella* and naked and partially exposed larvæ of top borer *Scirpophaga nivella* Fabricius. The life-cycle from egg to adult occupies 15 days. Trials to utilise this insect to control the two borers were made but with little success (Appanna and Shivashankara Sastry, 1953).

3. *Stenobracon deesæ* Cameron, *Stenobracon nicevillei* Bingham.—These parasitise the larvæ of *C. infuscatella*, *P. indicus* Kapur and *S. nivella*. Maximum activity is seen from May to September.

The range of parasitization of top borer larvæ is 0·6% to 6·8%. Similar examination of plants attacked by shoot borer revealed parasitization of shoot borer larvæ by *Stenobracon* to the extent of 1·4 and 1·1% in June and November 1954.

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4. *Rhaconotus scirpophagæ* Wilkinson, *Rhaconotus signipennis* Wilkinson.—These are active mostly from June to September. The extent of parasitization is 1·6 in June and 3·1 in August.

5. *Apanteles flavipes* Cameron.—This parasitises well grown larvæ of *Chilotræa*. Mating takes place nearly half an hour after ermergence and duration of mating lasts from 5 to 25 seconds. The female creeps through the tunnel in the stem pushing aside the frass on the hole cut by the host larvæ and parasitises the larva inside. The host larva may be completely fed upon by the grubs or it may remain greatly shrunk and dried up. In one instance, however, even after all the parasite larvæ had come out and were about to pupate, the host larva continued to live. Such an observation has been recorded elsewhere also (*Annual Report of Biological Control Research Officer*, 1945-46, Setabgunj). The life-cycle occupies 13–19 days (average 15·7). The number of the progeny from a single parasitised larva ranged from 9–34 (average 20·2). Females preponderate over males and the former lived for 2–5 days and latter for 1–3 days. Its recorded alternate hosts are *Chilo zonellus*, *Diacrisia obliqua*, *Creatonotus albistiga*, *Sesamia inferens*, *Proceras indicus*, etc. The percentage of parasitisation of shoot borer larvæ by this was 3·5 and 1·5% in June and August 1951, 6·3% in July 1952 and 1·8 and 3·9% in February and March 1954.

6. *Apanteles ruficrus* Haliday.—It is a parasite on the larva of *Euproctis* sp. which feeds on the leaves of sugarcane. The parasite has been known to parasitise *Cirphis loreyi* (Dup.), *C. unipuncta* (How.), *Heliothis armigera* Hubn., etc. (S. N. Rao, 1953).

Of the several braconid parasites mentioned above, individually each is not efficient by itself in controlling the insect. Their cumulative effect brings about increased control of *S. nivella*. *Apanteles flavipes* along with the other egg larval and pupal parasites may be of some importance in the check of shoot borer.

(B) Family: *Mymaridæ*

1. *Gonatocerus* sp.—This commonly parasitises the eggs of *Tettigella spectra* (Distant) during August–October (K. S. Shivashankara Sastry, 1957).

(C) Family: *Trichogrammatidæ*

1. *Trichogramma evanescens minutum* Riley.—This tiny chalcid wasp has been tried extensively in several countries for controlling sugarcane shoot borers. In Mysore, too, this has been studied by Kunhikannan (1931), Subramanyam (1937, 1939 and 1941), Subramanyam and Seshagiri Rao (1940), Krishnamurthy (1938) and Seshagiri Rao

(1940). The extent of parasitisation of the egg masses of the shoot borer in the V.C. Tract has been studied in recent years (Usman, Shivashankara Sastry and Puttarudraiah, 1957).

The adults when refrigerated at 4° C. (approx.) were completely benumbed, stuck to the walls of the container but sprang into activity after a short time of exposure to room temperature. The maximum period to which the adults could thus be cold stored was 10 days. The parasites so cold stored parasitised the host eggs and behaved normally. This fact has a practical advantage in maintaining a ready stock of parasites for purposes of release in young cane plots whenever required (Appanna and Shivashankara Sastry, unpublished records).

This species of *Trichogramma* is being employed on a field scale in the Biological control of sugarcane shoot borer in Mysore State (Usman *et al.*, 1957) resulting in an increased yield of 5–8 tons on an average per acre (Subramanyam, 1937, 1940, 1941).

2. *Trichogramma* sp.—Two varieties (i) The black and slightly smaller than *T. evanescens minutum* and (ii) Bigger and stouter in build and brownish, parasitise the eggs of *C. infuscatella* (rarely) and eggs of *S. nivella* respectively. The latter variety, whenever found, parasitises mostly the superficial or the peripheral eggs in an egg-mass.

3. *Oligosita* sp.—This has been recorded as a parasite on the eggs of *Tettigella spectra* (Distant) (Shivashankara Sastry, unpublished).

(D) Family: *Encyrtidæ*

1. *Ooencyrtus pyrillæ* Crawf.—It is parasitic on the eggs of *Dictyophara pallida* Don (*Pyrilla perpusilla*).

2. *Anagyrus saccharicola* Timb.—Natural parasite on adults and grown-up nymphs of *Saccharicoccus sacchari* Cokll. 6–14 adults (average 10·8) resulted from a single parasitised host collected from the field. Females preponderate over males in nature.

3. *Thysanus* sp.—It is related to *elongatus* Girault, parasitise the adults and nymphs of mealy bugs. 26–68·5% of the adults and nymphs (average 50%) are parasitised by Nos. 2 and 3 together (Puttarudriah, 1951).

4. *Anagyrus* sp. nr. *sweezeyi* Timb.—This parasitises the eggs of *Saccharicoccus saccharicola* Cokll. Only one parasite results out of one egg. The parasitised eggs, light-brown in colour, freely lie amidst the host stages.

Anagyrus sp. have been successfully utilized in Hawaiian Island to control the mealy bugs. They exert a good control of mealy bug

in nature in the V.C. Tract also and need detailed study and trials for control of the pest.

(E) Family: *Eupelmidæ*

1. *Eupelmella pedatoria* Fer.—This insect has been obtained (in its pupal and adult stages) from the top borer egg-masses parasitised by *Tetrastichus* sp. Exact role whether a secondary or a primary parasite requires to be determined. A similar species *E. vesicularis* has been described by Morris (1938) as having the habits of consuming several or all of the parasite stages contained in the host.

(F) Family: *Chalcidæ*

1. *Brachymeria* sp.—This parasitises the pupæ of *Lenodora vittata* Wlk. (Lasiocampidæ) whose larvæ feed on sugarcane, paddy leaves, and on grasses on the bunds of the cane and paddy plots.

(G) Family: *Eulophidæ*

1. *Tetrastichus* sp.—It parasitises the egg masses of *S. nivella* along with *Telenomus beneficiens* Zehntner and *Trichogramma* sp. (Subramanyam, 1939). Male emerges out earlier than the female, perches very near to the emergence hole on the egg mass and mates with the female immediately it emerges out. The female feels the egg mass for a few seconds, bends its abdomen and then inserts its slender ovipositor. The insertion may last for 10–25 sec. while actual oviposition extended to 40 sec. to 2 min. and 45 sec. Fresh egg masses are usually preferred, though three days old egg masses are also readily parasitised. Eggs with embryos already formed are also stung but not parasitised. The life-cycle from egg to adult occupies 13–17 days. The female lives for 2–35 days and male for 1–10 days with honey as feed and for 2–20 days and 1–8 days respectively without honey. The maximum progeny from one female was 53. Females preponderate over males. Parthenogenesis occurs giving rise to males only. The parasite is easily bred on the egg masses of *Schoenobius incertulas*. This parasite occurs almost throughout the year. The extent of combined parasitisation in nature by all the three parasites, *Tetrastichus* sp., *Telenomus beneficiens* and *Trichogramma* sp., ranged from 39·4% (February) to 98·2 (September).

Tetrastichus sp. parasitises a good percentage of the egg masses of *S. nivella* and can parasitise readily the egg masses of *S. incertulas* which also prevails in the tract when sugarcane top borer egg masses may be less available. This is a factor in its favour as an effective parasite in the control of top borer, *S. nivella*. For the present this and the other two parasites recovered from large-scale collections of

egg masses of top borer made from the field are being liberated back into the fields.

2. *Tetrastichus ayyari* Rohwer.—The parasite was first obtained out of the pupa of jola stem borer *Chilo zonellus* Swinhoe, in V.C. Tract. It has been bred in the laboratory on pupæ of a number of lepidopterous hosts including the sugarcane borers, *C. infuscatella* and *S. nivella*. The adult emerges out biting a hole on the host pupa. The female readily stings and parasitises the fresh host pupæ of the two borers and occasionaly well grown-up larvæ and rarely old pupæ from which moth is about to emerge in the laboratory. The life-cycle occupies from 14–18 days (average 16 days). The progeny of a single female ranged from 19–177. Females preponderate over males in laboratory cultures. Fed on honey a female lived from 12–32 days and male 6–8 days. Without feeding the female lived from 6–8 days and males died in 4 days. With the successful parasitisation of the pupæ of the sugarcane shoot and the top borers *in situ* in laboratory enclosures, field releases were undertaken against the two borers. A paper on the details of observations, field trials, etc., is in press (Puttarudriah and Shivashankara Sastry, 1957).

3. *Tetrastichus pyrillæ* Crawford.—This parasite along with *Ocencyrtus pyrillæ* Crawf. exerts certain amount of control though only in certain seasons. A total number of 15,559 eggs from 607 egg masses were examined for parasitisation by the two parasites and found to be on an average 17·3%. This was studied during 1951–56 as and when the material was available. Of the two parasites *Tetrastichus pyrillæ* is more common.

(H) Family: *Aphelinidæ*

1. *Azotus* sp.—It is a parasite on the sugarcane aleyrodid, *Neomaskellia bergii* Signoret, prevails in large numbers during October–December.

2. *Eretmo-cerus serius* Silv.

3. *Prospaltella* sp.—It also parasitises the nymphs of sugarcane aleyrodids.

(I) Family: *Elasmidæ*

1. *Elasmus zhentnerii* Feriere.—It parasitises larvæ of *S. nivella*. The male is smaller in size with branched antennæ; male courts the female for sometime and then copulates. Once mated female always tries to avoid being mated again. A single male may however mate with more than 2–3 females. The mating period lasts for 1–2 min. 20 seconds for courting and 1–5 sec. for actual copulation. The female prefers the larva within the web to exposed larva for oviposition. In

the laboratory cultures 9–34 (average 22) parasites emerged from one host larva. The life-cycle occupies 13–19 days (average 18·5 days). Females preponderate over males F : M : : 4·7 : 1. Females live for five days and males for 3–4 days. Trials to breed this parasite on other alternate hosts like *Corcyra cephalonica* by simulating natural conditions have not been successful so far.

Though seasonal n appearance, it may play a useful part in control of borers along with the egg and other larval parasites. The extent of parasitisation is 0·4 (Jan. and Nov.) and 6·8 (July).

(J) Family: *Scelionidæ*

1. *Amitus aleurolobi* Mani.—It parasitises nymphs of sugarcane aleurodid and is observed in the V.C. Tract.

2. *Telenomus beneficiens* Zehntner.—This is also an important egg-parasite of *S. nivella*. The female examines an egg mass carefully, extrudes the ovipositor, bends the abdomen, then inserts ovipositor into egg. In the act of oviposition the entire body lies vertical to the egg mass. A number of females may oviposit in different eggs in the same egg mass, but the moment one feels the presence of the other they fight each other and get disturbed; period of oviposition ranges from 30 sec. to 4 min. and 20 sec. (average 1·42 minutes). The individual host egg turns slightly greyish brown after parasitisation. Each host egg encloses within its envelope 2 stages of the parasites, each with its own individual envelope. Life-cycle is completed in 9–11 days. The adult parasite emerges out by puncturing its own envelope and then through the host egg envelope and the hairy covering of the egg mass. It is easily bred on paddy stem-borer egg masses. Eggs of *Corcyra celphalonica* were not at all preferred. However when eggs of *Lenodora vittata* Wlk. were provided the parasite extruded its ovipositor but the same could not be inserted probably because of the tough nature of the shell. This parasite occurs almost throughout the year. During certain seasons it is as common if not more, as *Tetrastichus* sp.

3. *Telenomus dignoides*.—It also occasionally parasitises the egg masses of *S. nivella* but less common than *T. beneficiens*.

4. *Telenomus*. sp.—It parasitises the egg masses of *C. infuscatella* and *P. indicus* especially the latter during April-May when the parasitisation is as high as 95–100%.

In Hawaii a species of *Telenomus* —*T. hawai*—has established itself after the liberations against *Spodoptera mauritia* Boisd., occasionally visiting cane [Francis and Williams (1931)].

(K) Family: *Dryinidæ*

1. *Dryinus pyrillæ* Kieffer.—It occurs in very small numbers as a parasite on the nymphs of *Dictyophora pallida* (Don.) (= *Pyrilla*

perpusilla). The extent of parasitisation ranged from 0·2–20% (average 5·2%). In the laboratory its oviposition habits were studied. The parasite catches hold of the nymphs, bends its abdomen and inserts its ovipositor at a point in between the thorax and abdomen. During this act the remaining body remains parallel to the host. The host nymph is helpless in the clutches of the parasite until it is dropped down. It remains as if dead for some time and regains its normal movement after nearly 20 sec. and lives till the bladder with the parasite grub in it bursts out. A host in which oviposition has taken place may be again attacked but egg laying takes place only on the point right opposite to it.

II. Order: DIPTERA

(A) Family: *Sapromyzidæ*

1. *Lonchæa* sp.—This is found in association with mealy bugs on cane. The exact role is not known.

(B) Family: *Drosophilidæ*

1. *Gitonides perspicax* Knab.—This is a common predator on the sugarcane mealy bugs. The maggots disorganising the adults and grown-up nymphs fed on their contents.

(C) Family: *Tachinidæ*

1. *Sturmiopsis* (Winthemia) *inferens* Townsend (*Semiberbis bezzi*).—It is a larval parasite of the shoot borer, *C. infuscatella*. Its other recorded hosts include *Sesamia inferens* Walker.

III. Order: LEPIDOPTERA

(A) Family: *Elachistidæ*

1. *Batrachedra amydrula* Stainton.—The larva of this moth is very often found in association with mealy bugs. The exact role is not known.

IV. Order: COLEOPTERA

(A) Family: *Cicindelidæ*

1. *Cicindela sexpunctata*.—This tiger beetle darts on and catches hold of the adult *Dictyophora pallida* and feeds on it. In an area near Maddur it appeared in large numbers and probably controlled the spread of leaf-hoppers which occurred in a pest form.

(B) Family: *Coccinellidæ*

1. *Nephus* sp.,
2. *Pullus* sp. and
3. *Pharoscymnus grimeti* Muls. are the common predators on *S. sacchari*.

4. *Cryptolæmus montrozoureii* has been observed to feed on mealy bugs in the laboratory (Puttarudriah, 1954).

V. Order: HEMIPTERA

(A) Family: *Anthocoridæ*

1. *Piezostethus* sp.—It is a predator on the cane mealy bug, *S. sacchari.*

(B) Family: *Reduvidæ*

1. *Isyndus heros.*—This assassin bug feeds on a number of hosts in the laboratory (Puttarudriah, 1958). The nymphs of sugarcane jassids *T. spectra* were also readily preyed upon. The beak is inserted into the sides or the ventral region of the nymphs and the contents sucked out leaving only a flaccid cover of the host.

VI. Order: ODONATA

Certain unidentified dragon flies are seen catching hold of and devouring the sugarcane leaf hopper, *D. pallida* (*P. perpusilla*).

NON-INSECT ENEMIES

Order: ACARINA

(A) Family: *Erythraeidæ*

1. *Leptus* sp.—This red mite attaches itself firmly to the nymphs and adults of *T. spectra* (Shivashankara Sastry, 1947) and a delphacid *Perkinsiella insignis* (Dist.) on cane and feed on them.

CLASS *NEMATHELMINTHES*

(B) Family: *Mermithidæ*

1. *Mermis* sp.—It has been obtained in association with *C. infuscatella.* The same has been recorded as a parasite on it.

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List of parasites and predators of sugarcane insects

HOST INSECT					PARASITE OR PREDATOR			
Order	Sl. No.	Name of host	Status of the insect	Stage of host attacked	Sl. No.	Name of the parasite or predator	Family	Season of occurrence
						(*a*) *Parasites*		
Lepidoptera	1	*Chilotræa infuscatella* Snell	Major	Egg	1	*Trichogramma evanescens minutum* Riley	Trichogrammatidæ	Throughout the year
					2	*Trichogramma* sp.	do.	Rare
					3	*Telenomus* sp.	Scelionidæ	Rare
		do.	Minor	Larva	4	*Apanteles flavipes* Cameron	Braconidæ	July to September
		do.			5	*Mirobracon chinensis* Szepligeti	do.	July–August
					6	*M. hebetor* Say.	do.	In the Laboratory
					7	*Stenobracon deesæ* Cameron	do.	May–September
				Pupa	8	*Tetrastichus ayyari* Rohwer	Eulophidæ	In the Laboratory
				Larva	9	*Sturmiopsis inferens* Townsend	Tachinidæ	Rare
					10	*Mermis* sp.	Mermithidæ	Rare
	2	*Proceras indicus* Kapur		Eggs	1	*Trichogramma* sp.	Trichogrammatidæ	Rare
					2	*T. evanescens minutum*	do.	Occasional
					3	*Telenomus* sp.	Scelionidæ	April–May
				Larva	4	*Apanteles flavipes*	Braconidæ	June–August & February–March
					5	*Stenobracon deesæ*	do.	May–September
				Pupa	6	*T. ayyari*	Eulophidæ	In the Laboratory
						(*a*) *Parasites*		
	3	*Scirpophaga nivella* Fabr.	Major	Eggs	1	*Tetrastichus* species	Eulophidæ	Throughout the year
					2	*Telenomus beneficiens* Zhentner	Scelionidæ	Throughont the year
					3	*Trichogaamma* sp.	Trichogrammatidæ	Almost throughout the year
				Larva	4	*Elasmus zhentnerii* Ferr.	Elasmidæ	June–September
					5	*Rhaconotus scirpophagæ* Wilkinson	Braconidæ	June–October
					6	*R. signipennis* Wlk.		

					7	*M. hebetor*	do.	In the Laboratory
					8	*S. deesæ*	do.	May–November
					9	*S. nicevillei* Bing.		
				Pupa	10	*T. ayyari*	Eulophidæ	In the Laboratory
	4	*Euproctis* sp.	Casual	Larva	1	*Apanteles ruficrus* Hal.	Braconidæ	June–August
	5	*Lenodora vittata* Walker	do.	Pupa	1	*Brachymeria* sp.	Chalcidæ	June–August
Hemiptera	1	*Dictyophara pallida* Don. (*Tyrilla perpusilla*)	Potential	Eggs	1	*Tetrastichus pyrillæ* Crawf.	Eulophidæ	July–October to December
					2	*Ooencyrtus pyrillæ* Crawf.	Encyrtidæ	
				Nymphs	3	*Dryinus pyrillæ* Keiffer.	Dryinidæ	September
						(*b*) *Predators*		
				Adults	4	Unidentified dragon fly.	Odonata (Ord.)	
					5	*Cicindela sexpunctata*	Cicindelidæ	June
						(*a*) *Parasites*		
	2	*Saccharicoccus sacchari* Cokll.	Minor	Adult & grown-up Nymphs	1	*Anagyrus saccharicola* Timb.	Encyrtidæ	
					2	*Thysanus* sp. related to *Elongatus* Girault		
				Eggs	3	*Anagyrus* sp. nr. *sweezei* Timb.	do	
						(*b*) *Predators*		
				Young Nymphs	4	*Nephus* sp.	Coccinellidæ	
					5	*Pullus* sp.		
					6	*Pharoscymnus grimiti* Muls.		
					7	*Cryptolæmus montrouzoureii*	do.	In the Laboratory
				Adult and Nymphs	8	*Gitonides perspicax* Knab.	Drosophilidæ	
					9	*Piezostethus* sp.	Anthocoridæ	..
					10	*Batrachedra amydrula* Staint.	Elachistidæ	..
						(*a*) *Parasites*		
	3	*Neomaskellia bergii* Sign.	Potential	Puparia	1	*Azotus* sp.	Aphelinidæ	..
					2	*Amitus aleurolobus* Mani	Scelionidæ	..
					3	*Coccophagus* sp.	Aphelinidæ	..
					4	*Eretmocerus* sp.		
	4	*Tettigella spectra*	do.	Eggs	1	*Gonatocerus* sp.	Mymaridæ	August–November
					2	*Oligosita* sp.	Trichogrammatidæ	do.
					3	*Tetrastichus* sp. Group of *Oecanthivorus* Gah.	do.	do.
						(*b*) *Predators*		
				Adults and Nymphs	4	*Leptus* sp.	Erythraeidæ (Acarina)	August–September
				Nymphs	5	*Isyndus heros*	Reduvidæ	In the Laboratory

OPTIMUM SPACING AND ECONOMIC SEEDRATE FOR GROUNDNUT CROP IN THE ARID ZONE OF NORTHERN KARNATAK

By N. B. Kajjari,[1] I. R. Morabad,[2] M. S. Salanki[3] and F. B. Kurthkoti[4]

Introduction

It is a well-known fact that the groundnut is an important food and commercial crop in India. Its popularity can also be ascribed to the ease with which it can be raised under varying soil and climatic conditions, the easy marketing of the produce and the attractive monetary returns obtained from it. Mysore stands third in the production of groundnut in India. Only seven Northern Districts of Mysore, namely, Bijapur, Belgaum, Dharwar, Bidar, Raichur, Bellary and Gulbarga Districts alone possess an acreage amounting to 84·46 per cent. in the State. Among these districts, Bijapur stand highest in acreage while Dharwar stands first from the point of view of production. Groundnut has, therefore, engaged great attention in the scientific research programme in the arid zone of Northern Karnatak. The main object of research on this commercial crop is to find out methods by which the cultivator could get maximum output with minimum cost. The quantity of seed per acre and the spacing required for sowing are the important factors governing the maximum production in an unit area while the cost of seed is an important factor in the cost of cultivation of the crop.

Review of Literature

Spacings and seedrates vary much according to soil and climatic conditions of the tract. Seshadri (1957) has reported that in the laterite soils of west coast, where rainfall is 100″ and above and where soils are deficient in lime, the optimum spacing would be 6″×6″ for bunch type and 9″×9″ for spreading type. The seedrate for bunch type is 80 lb. per acre and in Mysore and Bombay optimum spacing is found to be 9″×9″ and 12″×12″ respectively. Negi *et al.* (1957)

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have found that the optimum spacing under rainfed conditions in Panjab is 12″×9″ which on an average of 3 years' experimental results gave 52·4 per cent. higher yield at the farm and 46·7 per cent. on the cultivators' fields than the spacing 12″×24″ commonly practised by the cultivators. Tippannavar (1950) states that in the transition tract of Mysore groundnut responds well to closer spacing and higher seedrate and recommends that 12″ spacing and 80 lb. seedrate are better for early varieties of groundnut crop.

Many a time it has been felt necessary to adjust and adopt suitable spacings and seedrates convenient to the cultural practices of the tract. Seshadri (*loc. cit.*) states that in Madras State increasing the spacing between rows up to 1½–2′ and reducing spacing within rows to 3–8″ were tried in order to use intercultivation implements and the results revealed that the yields are not affected adversely.

In view of the above facts finding out suitable spacing and economic seedrate in different zones is quite important to get maximum returns from groundnut crop. In this paper are reported the results of research conducted in the Northern Karnatak zone to find out the economic seedrate per acre and suitable spacing between rows required for sowing the late and early types of groundnuts.

Materials and Methods

The seedrate-*cum*-spacing experiments reported here were conducted during the years 1952–53 to 1954–55 at the Agricultural Research Station, Bijapur and Annigeri. Bijapur is situated in the heart of the arid zone of Northern Karnatak which experiences frequent famines. Annigeri represents the arid part of the transition tract of Dharwer District. The two types of groundnuts used in these trials were *Spanish Improved* (erect-type) and *Pondicherry*-8 (spreading type). These varieties have been advocated by the Department of Agriculture for general cultivation in groundnut areas of Northern Mysore. The layout adopted was a split plot design with 3 main treatments for spacings and 3 sub-treatments for seedrates. Thus the spacings between two rows included 12″, 18″ and 24″ for the spreading type and 12″, 15″ and 18″ for erect type. The seedrates adopted for both types were 80, 100 and 120 lb. per acre. At Annigeri a trial was conducted on only one type of groundnut, *viz.*, *Spanish Improved.*

Results

The results of the experiments conducted at the Agricultural Research Station, Bijapur, are presented in Tables I, II and III.

TABLE I

Average yield in lb. per acre of spreading type of groundnut, PONDICHERRY-8, in different seasons at Bijapur

Seedrates	Spacings				
	12″	18″	24″	Mean	S.E.
			1952–53		
80 lb. ..	876	851	801	843	42·6
100 lb. ..	897	914	982	931	..
120 lb. ..	969	940	886	932	..
Mean ..	914	902	890	..	..
S.E. ..	76·7	..	..	..	..
S.E. of difference: (A) 104·4. (B) 138·0.					
			1953–54		
80 lb. ..	1235	1098	990	1107	43·5
100 lb. ..	1172	1089	1130	1130	..
120 lb. ..	1155	1141	1145	1147	..
Mean ..	1187	1109	1088	..	..
S.E. ..	21·1	..	..	..	..
S.E. of difference: (A) 106·6. (B) 92·0.					
			1954–55		
80 lb. ..	428	399	349	392	8·7
100 lb. ..	366	440	418	408	..
120 lb. ..	407	477	436	440	..
Mean ..	400	439	401	..	..
S.E. ..	15·5	..	..	..	..
S.E. of difference: (A) 21·4. (5B) 28·1.					
			Average results of 3 years		
80 lb. ..	846	783	713	781	20·5
100 lb. ..	812	814	843	823	..
120 lb. ..	844	853	823	840	..
Mean ..	834	817	793		..
S.E. ..	27·0	..	..	..	..
S.E. of difference: (A) 50·2. (B) 53·1.					

TABLE II

Average yield in lb. per acre of erect type of groundnut SPANISH IMPROVED, in different seasons at Bijapur

Seedrates	Spacings				
	12″	15″	18″	Mean	S.E.
		1952–53			
80 lb. ..	325	362	307	331	27·2
100 lb. ..	349	355	278	327	..
120 lb. ..	358	324	288	323	..
Mean ..	344	347	291	..	..
S.E. ..	27·4	..	..	..	..
S.E. of difference: (A) 66·6. (B) 66·8.					
		1953–54			
80 lb. ..	561	688	838	629	20·8
100 lb. ..	705	818	631	735	..
120 lb. ..	858	807	749	805	..
Mean ..	708	771	689	..	..
S.E. ..	18·5	..	..	..	..
S.E. of difference: (A) 41·6. (B) 49·0.					
		1954–55			
80 lb. ..	315	325	360	333	10·2
100 lb. ..	381	374	388	381	..
120 lb. ..	432	372	391	398	..
Mean ..	376	356	480	..	..
S.E. ..	15·1	..	..	..	..
S.E. of difference: (A) 25·0. (B) 29·5.					
		Average of 3 years' results			
80 lb. ..	400	458	435	431	11·9
100 lb. ..	478	516	449	481	..
120 lb. ..	549	501	476	501	..
Mean ..	476	492	453	..	..
S.E. ..	12·1	..	..	..	..
S.E. of difference: (A) 29·2. (B) 29·3.					

TABLE III

Average yield in lb. per acre of erect type of groundnut, SPANISH IMPROVED in different seasons at Annigeri

Seedrates	Spacings				
	12″	15″	18″	Mean	S.E
		1952–53			
80 lb. ..	605	609	577	597	11·2
100 lb. ..	633	609	644	628	..
120 lb. ..	682	624	646	651	..
Mean ..	640	614	622	..	..
S.E. ..	8·8	..	..	..	..
S.E. of difference: (A) 27·4. (B) 25·7.					
		1953–54			
80 lb. ..	1920	1682	1639	1747	46·3
100 lb. ..	1672	1824	1829	1775	..
120 lb. ..	2092	1752	1792	1878	..
Mean ..	1894	1752	1753	..	..
S.E. ..	40·9	..	..	..	..
S.E. of difference: (A) 113·3. (B) 109·1.					
		1954–55			
80 lb. ..	1399	1377	1419	1398	25·6
100 lb. ..	1494	1495	1403	1464	..
120 lb. ..	1510	1495	1476	1494	..
Mean ..	1468	1456	1433	..	..
S.E. ..	19·5	..	..	..	..
S.E. of difference: (A) 62·7. (B) 101·1.					
		Average of 3 years', results			
80 lb. ..	1308	1222	1212	1247	18·0
100 lb. ..	1266	1309	1292	1289	..
120 lb. ..	1428	1290	1305	1341	..
Mean ..	1334	1274	1270	..	..
S.E. ..	15·4	..	..	..	..
S.E. of difference: (A) 44·1. (B) 42·2.					

Discussion

At Bijapur and Annigeri the pooled analysis of 3 years' results show a significant interaction between spacing and seedrates indicating that the relative behaviour of seedrates is different at different spacings so far as the early erect type is concerned. On the whole 15″ spacing and 100 lb. seedrate per acre appear to be the best combination for Bijapur while 12″ spacing with 120 lb. seedrate is found best for Annigeri in case of early erect variety of groundnut, *viz.*, *Spanish Improved.*

In case of late spreading variety, *viz.*, *Pondicherry*-8, however, there is no significant difference between the different spacings and seedrates tried at Bijapur and further all the interactions are also non-significant. Twelve inches spacing with 80 lb. seedrate per acre has given consistently better yields at Bijapur.

Conclusions

In case of erect type of groundnut, *viz.*, *Spanish Improved*, 15″ spacing and 100 lb. seedrate for the scarcity zone may be suitable while 12″ spacing with 120 lb. seedrate appears best for the arid part of the transition tract. In case of spreading type of groundnut, *viz.*, *Pondicherry*-8, 12″ spacing with 80 lb. seedrate for the scarcity zone, can well be recommended to the cultivators of Northern Karnatak for adoption in groundnut growing areas.

Acknowledgements

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General and Review Articles

NEW VARIETIES OF FRUIT PLANTS IN COORG

By Dr. K. M. Aiyappa and P. P. Nanajappa*

1. "COORG HONEY"—A NEW PAPAYA VARIETY

"Coorg Honey" Papaya (*Carica papaya*) has taken the country by storm. Requests for seeds for this new variety is pouring in from all corners of the country. Mysore can be rightly proud of this achievement.

Papaya (*Carica papaya*) is an excellent breakfast fruit. It is wholesome, rich in sugar and digestive enzymes. It is also an important source of Vitamins A and C. Ripe fruit is a good dessert easy to serve without any preparation. The half-ripe fruit can be used as a vegetable and tough meat can be made tender by cooking with a slice of papaya. Papaya contains papain which is good in the treatment of dyspepsia and similar other digestive ailments.

The papaya plant is normally unisexual bearing male flowers on one plant and female ones on another. Only the female plants produce fruits. One can never predict whether a papaya plant will turn out to be a male or female. This is a serious handicap for the orchardist as he cannot predict how many of his plants will bear fruits.

But sometimes the papaya produces a bisexual type of plant called hermaphrodite. One such chance seedling selected at the Orange Research Station has consistently produced progenies with the same hermophrodite and pistillate characteristic, *i.e.*, all the plants raised from seeds of this type bear fruits. Seeds of this type are available with the Horticulturist, Orange Research Station, Chethalli, Coorg.

Description of the New Variety

'Coorg Honey', as the new variety is termed, is a short variety which comes to bearing within a year. The seeds are extracted from the fruit, partially dried in shade after mixing with ash to remove the gelatinous covering and sown in raised seed-beds. After two months of care in the seed-bed they attain a height of six to nine inches and can be lifted from the seed-bed and planted in the field in pits $1' \times 1' \times 10'$ apart. Manuring with farmyard manure 2 baskets and ammonium sulphate

* Orange Research Station, Coorg.

8 oz. per plant annually can be done regularly. Pest and disease control and cultivation operations should be done regularly. The tree produces fruits throughout the year, each tree giving 30–40 fruits weighng 90–120 lb. The fruits harvested in June–November are smaller in size, sweeter to the taste and almost seedless. This fruit does not have the undesirable odour that most papayas give out.

2. "COORG ORANGE ON CITRON"

Coorg Orange—*Citrus reticulata* Blanco, are famous in South India. Considerable research has been going on at the Orange Research Station, Chethalli, on this fruit for the last five years. A seedling orange comes to bearing in 8–10 years. One easy way out of this difficulty is to bud orange on desirable rootstocks when the plant will have predictable qualities and come to bearing early. More than 50 rootstocks are under trial at this Station and one of them seems wonderfully suited for using in kitchen garden. This is Citron—*Citrus medica* Linn., which when used as a rootstock produces dwarf mandarin plants with big size fruits with excellent flavour. The trees come to bearing in two years with a growth of about 200 cm. height and 175 cm. spread. They bear on an average 100 fruits per tree. They can be planted $8' \times 8'$ because of their small stature, which means nearly 675 trees can be planted to an acre giving an yield 67,500 fruits against 50,000 fruits in a seedling plantation. This is an ideal crop for kitchen garden, where limited space is available. This does not of course rule out the possibility of its commercial exploitation on large scale.

Hints on Cultivation

The Citron stock plants are raised from seeds. Freshly extracted seeds after partial drying in shade are sown on raised seed-beds. They germinate in 15–25 days and when they are ready for transplanting in nursery beds in 30–40 days, they are transplanted 9″ apart in the nursery beds. When they attain pencil thickness in 6–9 months, they are budded, the budwoods collected from the Coorg orange tree of known performance. After another 6 months the budlings are ready for transplanting in the main site. Pits $2' \times 2' \times 2'$ are dug 8′ apart and filled with good top soil and compost, and the budlings are planted preferably during June–September depending on the severity of monsoon. Manuring with compost 2 baskets, ammonium sulphate and superphosphate 8 oz. each per plant can be done in two doses before and after monsoon, till they start bearing. Afterwards the doses can be doubled. Removing of water shoots, dead twigs, stock sprouts, etc., should be done regularly. Pests and disease control must be done rigidly.

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GIBBERELLIN—A NEW PHYTOHORMONE

By D. V. Murthy*

Introduction

In the rice growing countries of Far East, rice plant is often susceptible to a disease termed '*Bakanæ*' or "foolish seedling" caused by the fungus *Gibberella fujikoroi* (Sawada) Wollenw. The affected plants grow unusually taller and then die. It was Yabuta and Sumiki (1938) who first announced the isolation of two crystalline biologically active principles which they termed as Gibberellins A and B. Later, scientists working at the Northern Research Laboratory of the United States Department of Agriculture and at the Imperial Chemical Industries in England also independently announced the isolation of Gibberellic acid ($C_{19}H_{22}O_6$). So far four separate compounds of Gibberellin have been isolated and are under study. It is however only since last year commercial supplies of this hormone have become available for intensive trials. They are available mostly in the form of dry powders but are also being formulated in the form of liquids and ærosols too. Commercial production of this hormone has commenced in Japan, United States of America and Britain.

Effects on Plant Growth

Responses of plants to Gibberellin vary considerably and a good deal of research is being carried out on many economic plants. Gibberellin has both its favourable and deleterious effects on plants receiving its application. In general it is seen that Gibberellin, even in minute quantities, is able to stimulate growth parts of the plant above the soil, especially leaves. On the root crops, however, the effect of this compound is negligible and in certain cases there may even be reduction in yields. Amongst several methods of application, the most effective appears to be foliar application. Application to the soil is not advocated since the chemical is destroyed by soil micro-organisms. To take fullest advantage of Gibberellin application, application of nitrogenous fertilisers should be preceded. Action of the hormone is found greater on younger crops than on grown-up crops.

In the matter of growth of plants, Gibberellin stimulates elongation. With crops grown for vegetation the increased elongation is often accompanied by an increase in yield as a consequence of increased photosynthesis from a larger leaf-area. Hayashi and Murakami

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(1958) have reported a substantial increase in the yield of hemp when Gibberellin was used as a foliar spray twice. In some cases, however, the overgrowth produced by Gibberellin is not desirable or may be accompanied by harmful effects like weakening of the stem, lodging, etc. It also induces sprouting of dormant potato tubers.

As regards flowering, it has been observed that flowering in tomatoes and beans is accelerated. If flower-buds of geranium are sprayed with only 1–10 p.p.m. when they begin to show colour, flower clusters that are double than the normal size are produced.

In brinjals, cucumbers and tomatoes spraying with 10–100 p.p.m. of Gibberellin results in formation of fruits without pollination. In seedless grapes, fruits with larger individual berries are produced.

Seed treatment with Gibberellin in general induces the same growth responses in seedlings as those observed when spraying is done on young plants.

One of the interesting aspects of Gibberellin application is its ability in some instances to induce growth in plants exhibiting stunted growth an account of fungal or virus infection. There is some evidence that in some cases the affected plants may outgrow the effects of the fungal infection.

Conclusions

In conclusion it may be mentioned that a lot of research is still to be carried out before Gibberellin is put into commercial use. To quote Brian and Grave (1957), " we may therefore conclude that such field experiments as have been carried out do not yet indicate any major use for Gibberellic acid in Agricultural practices and that far more field experimental work will be needed before a sound assessment of the prospects can be made." This much is certain that a valuable tool has become available in the lands of Plant Physiologists and Agronomists and the coming years may reveal the true potentialities of this hormone isolated from the fungus of *Bakanæ byo* on rice.

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CITRUS CANKER—*XANTHOMANAS CITRI* (HASSE) DOWSON

By Dr. K. M. Aiyappa*

Introduction

Important to successful citrus growing is prevention and control of diseases. Many of the diseases are aggravated by neglect or mismanagement and usually are preventible with little care. Some, however, are serious and frequently require drastic measures and constant attention if they are to be prevented or cured. Among the latter groups citrus canker [*Xanthomonas citri* (Hasse) Dowson] is an important one which is widespread in India. But the damage caused by this disease is not correctly assessed yet, nor has any concerted efforts been made to check the spread of the disease. Obviously the latent danger of this disease has not yet been realised by the citrus growers in India, though it has of late assumed serious proportions. In this connection it would be worthwhile to recall that in the U.S.A. in Florida alone more than $ 2,500,000 of State, Federal and private funds were spent between the years 1914–31 to eradicate the disease and an effective control campaign and systematic inspection of groves has been in force with the result that there is no infection of groves since 1927. The apparently complete eradication of this dreaded disease from South Africa, Florida and Gulf States is one of the most outstanding accomplishments in the history of plant disease control. Since 1915, safeguards against their entrance into American citrus regions have been afforded through the Federal and State quarantine regulations and their enforcement.

Causal Organism

The causal organism for this disease is a bacterium originally described as *Pseudomonas citri* (Hasse, 1915) which was later on thought to be *Phytomonas citri* (Fawcett, 1936) but now identified as *Xanthomonas citri* (Beed *et al.*, 1948). The disease had its original home either in China (Tanaka, 1918) or India (Fawcett and Hayes, 1953). Some herbarium specimens sent from Dehra Dun to Kew prior to 1831 had the bacteria. The citrus canker organism is a short rod with rounded ends measuring 1·56–2·97 by 0·45–1·47 μ. The organism isolated from limes and malta and nepali lemons is a short rod measuring 1·4–2·8 by 0·7–1·4 μ gram negative, capsulated, non-spore-forming monotrichous and motile (Rangaswami and Rajagopalan, 1957).

* Horticulturist, Gonicoppal, Coorg.

These bacteria are found in countless numbers in the canker spots and are exuded in masses whenever the spots become moistened by rain or dew. Drops of water contaminated with bacteria spread the disease and when the organisms come into contact with susceptible citrus tissue especially the tender foliage, twigs and young fruits, new canker spots develop readily. In the older bark, on the branches and trunks the bacteria probably gain entrance through small wounds or cracks. The disease may be spread some distance by wind and driving rains and any animal or insect coming into contact with the moistened foliage. The chief agent in the dissemmation of canker, however, has been man. The disease often may remain inactive for a considerable period after infection has taken place before developing the usual symptoms (Hume, 1957). The optimum conditions for infection of leaves are a temperature range of 68–95° F. and free moisture for twenty minutes or more on the surface of the rapidly growing tissues (Peltier, 1920; Peltier and Frederich, 1926; Ramakrishnan, 1954). Leaf miners, *Phyllocnistis citrella* and *Thosconyrsa citri* also open up the way for infection by the canker organism (Clausen, 1931; Hayes, 1953; Kurisaki, 1919 and 1920). Infections on the leaves first appear as small watery dots with raised convex surfaces. They gradually increase in size, change to light-brown colour and become visible on both sides of the leaf. In the older spots, one or both the surfaces may be bulged commonly surrounded by a narrow yellowish band or zone. The old spots soon become overgrown by saprophytic fungi and may appear pink or black. The spots on fruits are very similar to those formed on leaves but do not penetrate into the flesh of the fruit (Fawcett, 1936), The spots on young twigs are like those found on the leaves and fruit, more prominent, but do not penetrate into or kill the wood. Other citrus diseases with which canker may be confused are scab, necrosis, scaly barks or nail head rust, and anthracnose.

Inoculation experiments have shown that large number of species and varieties and hybrids and wild relatives of citrus are more or less susceptible to canker (Hume, 1957; Rangaswami and Rajagopalan, 1957). Citrus canker attacks all varieties of citrus trees of commercial importance. Any part of the tree above ground may become infected. Grape fruit (*C. paradisi* Macf.) is most severely attacked (Berger, 1914). The trifoliate orange, *Poncirus trifoliata* is next in suceptibility followed by the limes *C. aurantifolia* Swingle other than Tahiti, sweet orange [*C. sinensis* (Linn.)] Osbeck, and lemons [*C. limon* (Linn.)] Osbeck (Lee, 1918). Mandarin orange (*C. reticulata* Swingle), citrons (*C. medica* Linn.), Pummeloes [*C. grandis* (Linn.) Osbeck], and a few species of kumquats (*Fortunella* sp.) have a very slight degree of susceptibility and are commercially resistant (Fawcett, 1936). Mandarin oranges are

more resistant than grape fruit probably because the stomatal openings in Mandarin are more narrow and much less subject to water entrance (Machean, 1921; Machean and Lee, 1922). In India canker is found commonly on limes and lemons and not much on Mandarins or sweet oranges (Govinda Rao, 1954; Peltier and Frederich, 1926; Ramakrishnan, 1954; Venkatakrishnaiah, 1956). At the Research Station at Athur, Gonicoppal (Coorg District), there was severe outbreak of this disease on Rough lemon (*C. jambhiri* Lush). This has not been reported so far elsewhere in the world. Nearly 4,000 seedlings were destroyed.

Citrus canker is also called *Cancrosis* A. There is another similar disease called *Cancrosis* B which has not so far been reported in India but which is prevalent in Argentina, Uraguay, Peraguay and is most severe on lemons and occasionally on oranges.

Control Measures

For the control of the disease, a wide range concerted Governmental action is necessary. This includes complete destruction of all canker infected trees by burning and disinfecting the tools, cloth, and strict enforcement of plant quarantine methods for prevention of re-entry from other countries. Burning individual plants severely affected (providing windbreaks to prevent dissemination of the bacteria). Spraying of lime sulphur, ultra sulphur or Bordeaux mixture 8–8–100, and contact insecticide against aphids, and leaf miner and growing resistant varieties are some of the measures that are being advocated* (Fawcett, 1936; Hume, 1957; Govinda Rao, 1954; Lee, and Shino, 1922; Luthra and Sattar, 1942; Naik, 1949; Venkatakrishniah, 1956). In the nursery all affected plants should be destroyed and Bordeaux mixture sprayed once in three weeks.

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Abstracts

PLANT BREEDING AND GENETICS

1. Arakeri, H. R. (1956). "A note on storage and germination requirements of seeds and suran (*Amorphophallus campanulatus*)," *The Indian Journal of Genetics and Plant Breeding*, **16**, 60–61.

The reason for the failure of seed setting in this crop which is normally propagated vegetatively is stated to be the protogynous condition of the flower and peculiar structure and development of the flower unfavourable for wind or insect pollination. The seeds, however, could be produced by cross-pollination. The difficulty in germination was recorded and various methods of storage are discussed to overcome this malady. The conclusions drawn are that the seeds could be stored in a cool dry place. Exposure of seeds so as to allow it to dry or to low temperatures for long time would result in mortality of the seeds.

(S. R. CHANDRASEKHARIAH)

2. Pal, N. L. and Gopalachari, N. C. (1957). "Studies on the germination of tobacco seed—I. Germination of some commercial varieties of tobacco," *The Journal of the Indian Botanical Society*, **36**, 262–63.

While studying the germination of about 23 varieties of tobacco, considerable variation in germinating power was encountered among the different varieties. The germination was tried at 35 and 37·8° C. and it is concluded that the more recently introduced varieties had lower germinating capacity than the varieties acclimatised under Indian conditions for a long time (with some exceptions) and those acclimatised Indian varieties had shown high germination at temperatures higher than those reported as optimum in foreign countries.

(S. R. CHANDRASEKHARIAH)

3. Kempanna, C. and Krishna Sastry, K. S. (1958). "Male sterility in *Crotalaria striata*," *Curr. Sci.*, **27**, 181.

The authors have reported the occurrence of male sterility in *Crotalaria striata*. It is inferred that male sterility is cytoplasmic. The possibility of utilising this in the exploitation of hybrid vigour is indicated.

(S. R. CHANDRASEKHARIAH)

4. Argikar, G. P. (1956). " Some qualitative and quantitative observations on the genetic improvement of a green seeded strain o *Cicer arietinum*," *The Indian Journal of Genetics and Plant Breeding*, **16**, 52–56.

The green, small seeded, low yielding type possessing green cotyledon having been found to be rich in protein and ascorbic acid was crossed with the improved bold, yellow grained high yielding strain *Badachana* containing low protein and ascorbic acid. The object was of making selections for a combination of all the desirable characters like high yielding, bold green seeded strain rich in protein and vitamin C. The author has described the technique employed to make selections for the desirable characters.

(C. KEMPANNA)

5. Dharmapal Singh, Mittal, S. P. and Gangawar, L. C. (1956). " Breeding for wilt resistance in linseed in Uttar Pradesh," *The Indian Journal of Genetics and Plant Breeding*, **16**, 29–31.

A rust resistant N.P. (R.R.) 9 linseed found to be wilt resistant also with good agronomical qualities was crossed with type and other promising hybrid selections in Uttar Pradesh and it is reported that the material is in F 3 stage. It is found that resistance to wilt was dominant over susceptibility and a single factor was found to control the reactions of resistance and susceptibility.

(C. KEMPANNA)

6. Appala Naidu, B. and Shankara Rao, K. S. R. K. (1958). " Effect of transplantation on ragi plant," *The Journal of the Indian Botanical Society*, **37**, 194–99.

The authors have studied the influence of transplantation on the growth of root and shoot systems and the yield in *Eleusine coracana* Gaertn. Seedlings were transplanted in the third week after sowing according to normal practice. Second transplanting was undertaken in the second week after first transplantation. The authors' obsrvations show that the later transplanted plants exhibited more number of tillers, more total shoot and root length. The number of laterals per inch of root were comparatively more. The yield of straw and grain increased considerably. This increase in yield of the second transplantation plants, according to authors, may be due to increased root formation after transplanting. Roots grow vertically in untransplanted plants, whereas in transplanted plants they prefer to grow laterally. Correlation between root system, tillering and yield have been observed.

(S. R. CHANDRASEKHARIAH)

7. John, C. M., Venkatanarayana, G. and Seshadri, C. R. (1954). " Varieties and forms of groundnut, their classification and economic characters, " *The Ind. J. Agric. Sci.*, **24**, 159–93.

An attempt to classify the collection of groundnut comprising 85 varieties and forms, at the Groundnut Research Station, Tindivanum (South Arcot, Madras) during the last two decades has been made. The study has revealed 40 distinct varieties and forms and these are recognised and grouped into 7 main groups and 22 subgroups based on their morphological and economic characters. It is indicated that the area under groundnut in India in 1850 was only 4,000 acres and was raised to 10 million acres with an annual production of 3·5 million tons (unshelled nuts) by 1954. Some 13 species of *Arachis* have been described by botanists. Of these about six only are considered to be distinct. All the cultivated forms belong to the species *Hypogæa* which comprises five distinct botanical varieties, namely, variety *oleifera*, var. *nambyquaræ*, var. *rasteiro*, var. *asiatica* and var. *gigantia*. Though varieties *nambyquaræ*, var. *rasteiro*, var. *asiatica* and var. *oleifera* have been variously described as species, subspecies or types by different workers, they are for the sake of uniformity recognised by the authors only as botanical varieties and all the cultivated forms of groundnut are included under var. *oleifera*.

(C. Kempanna)

8. Sen, S. and Joshi, M. G. (1955). " Inheritance of resistance to black rust in wheat, " *Indian Journal of Genetics and Plant Breeding*, **15**, 37–46.

The authors have discussed the inheritance of certain characters like mature plant reaction to black rust, awnedness, pubescense and colour of glumes in three varietal crosses of bread wheat (*Triticum æstivum*) and concluded that in two crosses the mature plant reaction to black rust appeared to be dependent on a single pair of genes, susceptibility being dominant. The dominance of long tip awns seemed to be governed by a single pair of genes in two crosses whilst in another cross the segregations in F 2 and F 3 were irregular; the inheritance of awnedness in this cross seemed to be governed mainly by a single factor pair, the long tip character being dominant to full beardedness and some modifying factors are assumed to explain the additional variation. The inheritance of a pubescence character appeared to have been dependent upon a single pair of genes, the pubescence being dominant. Inheritance of glume colour is concluded to be dependent on the interaction of two complimentary genes in the cross. All the characters studied appear to be unlinked.

(C. Kempanna)

AGRICULTURAL CHEMISTRY

1. Better fruit juice extraction, *The S.A. Sugar Journal*, **42** (3), 1958.

A new process called " electroplasmolysis " for the pre-treatment of fruit and vegetables prior to the extraction of juice has been developed by a Soviet scientist. In this method A.C. current of 220 volts and 50 cycles is passed through the fruit pulp for a short time, which is believed to increase the permeability of the cell-walls resulting in a larger juice yield. It is claimed that juice produced is increased by 12 to 20%.

(T. Seshagiri Rao)

2. Ponnamperuma, F. N. (1958). " Lime as a remedy for a physiological disease of rice associated with excess iron, " *Int. Rice Comm. Newsletter*, **7** (1), 10.

It is believed that the physiological disease of rice, known as " bronzing " or " browning " disease is due to the excess of soluble iron in the soil solution. Preliminary experiments have shown that the disease can be prevented by the application of lime to raise the pH to about 6·0.

(T. Seshagiri Rao)

3. McColloch, R. C., *et al.* (1957). " Relation of soil K and Mg to Magnesium nutrition of citrus, " *Proc. Soil Sci. Soc. Amer.*, **21** (1), 85.

Soil and leaf analyses were made in connection with six field experiments involving orange trees fertilized with K and/or Mg.

The concentration of Mg in spring-cycle leaves was correlated with the degree of leaf symptoms characteristic of Mg deficiency. Addition of Mg fertiliser resulted in a marked increase in leaf Mg and a disappearance of deficiency symptoms. K fertilization accentuated Mg deficiency. Deficiency symptoms were associated with leaf Mg concentrations of 0·20% or less. The ratio of exchangeable K/Mg in the soil (particularly the 18–30″ depth) was highly correlated with the per cent. Mg in the leaves.

(T. Seshagiri Rao)

4. Blanchet, R. (1957). " The effect of humus colloids on the various phases of nutrient absorption by plants, " *C.R. Acad. Sci., Paris*, 244.

In presence of 0·5–2 mg./l. humate the absorption of K and P was considerably increased when deficient wheat seedlings were grown in

nutrient solutions. The absorption of these elements continued to increase in presence of small amounts of humic matter, but the relative differences diminished with time. Results suggest that humic matter increases the rate of nutrient absorption by accelerating the surface absorption of mineral ions on the root colloids.

(T. Seshagiri Rao)

ENTOMOLOGY

1. Fernando, H. E. and Peiris, J. W. L. (1957). "Investigations on the chilli leaf-curl complex and its control," *Trop. Agric.*, **113** (4), 305–24.

In Ceylon five factors appear to be responsible for chilli leaf-curl and other malformations—mites, thrips, vein-clearing virus disease, leaf mottle virus disease and tobacco mosaic virus. The thrips (*Sciroto thrips dorsalis*) and mites (*Hemitarsonemus latus*) induce leaf-curl mostly by mechanical injury. The vein clearing virus and the leaf mottle virus could be transmitted by the white fly (*Bemisia inconspicua* and the aphid *Aphis gossypii* respectively. Apart from the above three virus diseases, little leaf and mosaic are also now recognised. The factors responsible for the high incidence of chilli pests are said to be the cultivation of solanaceous crops continuously without proper rotation, and other insanitary cultivation measures. Tests with a number of pesticides have revealed the control of leaf curls induced by mites and thrips but not those caused by virus. The authors conclude that breeding for virus resistant varieties hold out a satisfactory promise in the control of chilli leaf-curl complex.

(D. V. Murthy)

2. Simmonds, F. J. (1958). "The successful breeding of *Palpozenillia palpalis* (Ald.) (Diptera, Tachinidæ), a parasite of *Diatræa* spp.," *Trop. Agric., Trin.*, **35**, (3), 218–25.

Palpozenillia palpalis (Ald.) is an economically important parasite of several species of *Diatræa* which are well known sugarcane and other cereal stalk borers. Breeding of this important parasite in the laboratory had so far proved unsuccessful and the author has described a successful breeding technique, utilising *Zeadiatræa lineolata* Wlk. which is an important maize pest, in pieces of sugarcane, the cane being cut so that the piece bear the external opening of the larval tunnel. It is reported that extensive recovery collections have been made after releases in Trinidad.

(D. V. Murthy)

3. Venugopal, S. (1957). "*Semiothisa pervolgata* Wlk., a semilooper pest on *Sesbania aculeata* (Dhaincha)," *J. Madras Univ.*, **27 B** (2 and 3), 287–93.

Dhaincha (*Sesbania aculeata*) is an important green manure crop in South India. The author has recorded his observations on a geometrid pest, *Semiothisa pervolgata* Wlk., the larvæ of which defoliates the leaflets of the Dhaincha plants rendering them naked. The entire life-cycle of the insect is completed in 20–23 days (Egg period: 3–4 days; larval stage; 10-12 days with 5 moultings; pupal period: 6–8 days). The insect is kept in check in nature by the larval parasite *Apanteles hypsipylæ*, Wlk. (Braconidæ).

(D. V. MURTHY)

4. William, R. Young and Rawlins, W. A. (1958). "The persistence of Heptachlor in soils," *Jour. Econ. Ent.*, **51** (1), 11–18.

Residual action of insecticides in soils is an important problem to be reckoned with in these days of wide application of chemicals to control noxious pests of crops. The authors have studied the residual properties of Heptachlor in four types of soil, namely (1) silty clay loam; (2) Silt loam; (3) Muck; and (4) Sandy loam. Both colorimetric chemical analysis and bioassy were employed for evaluation purposes. Rapid losses occur in coarse textured soils low in organic matter and adsorptive properties. When used directly to the soil for treatment of soil inhabiting insects Heptachlor will persist for longer periods than when applied for the control of foliage pests. It is concluded that when used in the dosages recommended for control of crop-pests, Heptachlor will not accumulate to dangerous levels in cultivated soils.

(D. V. MURTHY)

5. Lofgren, C. S., Keller, J. C. and Burden, G. S. (1958). "Resistance tests with the bed bug and evaluation of insecticides for its control," *Jour. Econ. Ent.*, **51** (2), 241–44.

Tests were conducted in Homes, Rooms and Apartments where 1–2 pints of odouless kerosene solution were applied to bed frames. mattresses and wood work in infested rooms against *Cimex lectularius* L. and *C. hemipterus* F. Each mattress was sprayed until it had a frosty appearance. Results obtained show that 0·5% diazinon was best followed by Diazinon 0·1%. With Dow ET-57, Dipterex, Chlorothion, Malathion, Dieldrin and DDT, 2–8 days were required to achieve complete control. It is reported that in many areas including Bombay in India, *C. letucularis* has developed resistance to DDT. Synergised

pyrethrins give complete control in two days but newly hatched nymphs are found present after a week.

(D. V. MURTHY)

6. Walstrom, R. J. (1958). " Effects of flight distances from Honey Bee colonies on red clover seed yields, " *Jour. Econ. Ent.*, **51**, 64–67.

This is a report of study conducted by the author to determine the effects of Honey Bee (*Apis mellifera* L.) activity on red clover seed production from 1951–53, inclusive. There appears to be significant correlation between seed yields of red clover and the distance between the hives. Under Central Iowa conditions where the study was conducted, it is concluded that maximal pollination efficiency occurs within 400′ from the location of the hives.

(D. V. MURTHY)

7. Allen, H. W. (1958). " Orchard studies on the effect of organic insecticides on parasitism of the oriental fruit moth, " *Jour. Econ. Ent.*, **51**, 82–87.

The oriental fruit moth *Grapholitha molesta* is an important insect pest in peach orchards. Previous studies made by workers in laboratory and cage tests had shown that a number of common parasites of this insect are more readily killed by organic insecticides than the oriental fruit moth itself. In a detailed study made under orchard conditions from 1948–53, the author has pointed out that the potential capacity of parasites to reduce *Grapholitha* infestations has not been appreciably affected by the general use of the new insecticides.

(D. V. MURTHY)

8. Carpentier, L. J. (1958). " Recent attempts to establish sugarcane borer parasites in Louisiana," *Jour. Econ. Ent.*, **51** (2), 163–64.

Results of recent tests to introduce larval parasites of the sugarcane borer *Diatræa saccharalis* F. are reviewed in this short paper. The larval parasites introduced were *Metagonistylum minense* Twons, *Lixophaga diatrææ* Towns, from Trinidad. B.W.I., *Agathis stigmaterus* Cross, from South America; *Apanteles angaleti* Meus., *Bracon brevicornis* Wesm., *Chelonus* n. sp. and *Chelonus heliopæ* Gupta from India. Out of the above *Lixophaga diatrææ* has been found established in fields upto two miles from the release points. Few cocoons of *Agathis stigmaterus* were also recovered. None of the four parasites got from India were recovered.

(D. V. MURTHY)

9. Shands, W. A., Thompson, C. G., Simpson, G. W. and Wave, H. E. (1958). "Preliminary studies of entomogenous fungi for the control of potato infesting aphids in Maine," *Jour. Econ. Ent.*, **51** (2), 184–86.

An introduced fungus *Acrostalagmus* is reported to have been successfully established by dissemination of laboratory cultured spores against the potato aphid *Macrosiphum solanifolii* Ashm. in a field test. The fungus for producing the spores were cultured on cooked slices of potato tuber about 3/8″ thick and held in petri dishes at a constant temperature of 76° F. for ten days or until a heavy crop of spores was ready for harvest. It was also propagated on potato infusion agar supplemented by 1% dry yeast. To prepare spray suspension of the spores, the culture material was mixed with rain-water and aliquots were placed in separate containers. It is indicated that large populations of the potato aphid are not necessary for establishment of *Acrostalagmus* in the field.

(D. V. Murthy)

10. Szent Ivany. J. J. H. and Barrett, J. H. (1956). "Some insects of Banana in the territory of Papua and New Guinea," *Papua and New Guinea Agri. Jour.*, **11** (1), 40–44.

Cosmopolites sordidus (Weevil borer), *Nacoleia octasema* Meyr. (Banana Seab moth), *Papuana lævipennis* Arrow (Taro beetle), *Scapanes australis* Boisd., *Scapanes grossepunctatus* Sternb. (Rhinoceros beetles), *Dermolepida nigrum* Nonfrid (Cockchafers), *Apirocalus cornutus* Pasc (Curculionid weevil), *Strumata musæ* Try. (Fruit flies), *Tænaris myops kirschi* Stgr. (leaf caterpillar), an unidentified capsid bug, *Stephanitis* sp. (lace wing bug), and an unidentified species of Derbidæ are some of the insects recorded on Banana by the authors. Short notes on each species are given.

(D. V. Murthy)

11. Puttarudriah, M. (1958). "*Helopeltis antonii* Signoret on guava (*Psidium guava*)," *Sci. and Cult.*, **24** (3), 139–40.

In a previous communication [*Mys. Agr. J.*, **28** (8), 1952] the author had recorded *Helopeltis antonii* as causing scab or blisters on guava fruits. In the present communication he has pointed out that the symptoms of leaf-twisting with small pink patches along with drying up of twigs which are commonly met with in guava orchards are also due to *Helopeltis* attack. The characteristic symptoms could be artificially produced by enclosing nymphs and adult bugs on healthy twigs with leaves.

(D. V. Murthy)

12. Valsala, P. G. (1958). " A white grub attacking roots of coconut palm," *Coconut Bull. Ind.*, **12** (6), 240–44.

Leucopholis coneophora Burm. is an important insect pest of coconut palms in India. On account of attack by the grubs of this beetle, roots are severed and consequently the leaves turn pale yellow and immature nuts fall off from the bunches. The life and seasonal histories along with control measures are given by the author. Application of 5% chlordane dust (28 lb./acre) or 5% BHC dust (56 lb./acre) once a year after South-West Monsoon rains controls the pest.

(D. V. Murthy)

AGRONOMY

1. Spooner, A. E., Caviness, C. E. and Spurgeon, W. I. (1958). " Influence of timing of irrigation on yield, quality and fruiting of upland cotton, " *Agron. Jour.*, **50** (2), 74–77.

Effect of applying irrigation water all season, starting from first bloom and at 20 days old bolls as compared to no irrigation, studied in Arkansas (U.S.A.) are reported.

In general the yield increases by about one bale are reported due to application of irrigation water. Irrigation has extended the peak of fruiting by two weeks, decreased the shedding, increased the boll size and has not lowered the quality of cotton.

(H. R. Arakeri)

2. Ramage, C. H., Claude Eby, Robert E. Mather and Ernest R. Purvis (1958). " Yield and chemical composition of grasses fertilized heavily with nitrogen, " *Agron. Jour.*, **50**, 59–62.

The results of the investigations conducted in Northern New Jersey (U.S.A.) to study the effect of heavy nitrogen fertilisation on the yield and quality of forage are reported in this paper. The dosages included are 50, 100, 200, 400 lb. of nitrogen per acre per year.

The yields of forage material and protein percentage increased from 2–4·5 tons and 12–20 respectively with an increase of dosage of N from 50–400 lb. However the rate of 100 lb. given the highest yield of dry material and protein per lb. of N applied. This treatment was the most efficient from the view of the cost also.

(H. R. Arakeri)

3. Reid, P. H. and York, E. T. (Jr.) (Feb. 1958). "Effect of nutrient deficiencies on growth and fruiting characteristics of peanuts in sandcultures," *Agron. Jour.*, **50** (2), 63–67.

Sandculture studies supplied with culture solutions designed to characterise deficiencies of important nutrients (N, P, K, Mn, Fe, Ca, S, Zn, Boron and Molybdenum) and its effect on growth, flower and pod development of groundnut have revealed the following:—

(1) Deficiencies of all the elements studied reduced top and root growth in general although to varying degrees.

(2) Flower production was reduced in all treatments except the treatments not receiving manganese and molybdenum.

(3) Withholding of supplies of phosphorus, manganese, molybdenum and copper after early flowering did not reduce formation of pods.

The deficiencies symptoms have been described in full.

(H. R. Arakeri)

RESEARCH IN PROGRESS

In the Division of Agricultural Chemistry, Bangalore, a soil map of the present enlarged Mysore State was prepared during the quarter under report. Seven broad soil groups are now identified as existing in the State. In a study of soils of the Agricultural Research Station, Nagenahally, which have been under intensive manuring and cultivation of paddy for a number of years, it was found that there is a tendency of the soils towards becoming acidic. The contents of soil nitrogen and organic matter have, however, been considerably increased.

In an experiment on the influence of green manure on phosphate utilisation by paddy crop, fairly good responses to small doses of P (10 lb. P_2O_5/acre) with green manure were observed at higher nitrogenous levels. Similarly, marked responses were obtained at two research stations to application of superphosphate (10 lb. P_2O_5/acre) composted one month prior to application.

In a long term manurial experiment it was found that there is increased nitrogen fixation by Sann-hemp (*Crotalaria juncea*) with increased soil phosphate status built up by repeated application of phosphates.

Confirmatory results have been obtained, that when liquid nitrogen is directly applied to soil for fertilisation of paddy and sugarcane, the value of nitrogen is found equal to that supplied by application of ammonium sulphate. In trials with various methods of application of ammonium sulphate nitrate to paddy, at 30 lb. nitrogen per acre, two split doses—one at planting and another at flowering time, were found to give about 11% more yield than application of two similar split doses of ammonium sulphate.

Studies on the influence of application of increasing levels of green manure on soil fertility factors on paddy were continued by the Division of Agricultural Chemistry at Nagenahally. While there were no significant increases in fields of paddy in the previous years, increased yields were obtained in the current year with application of green manure at 6,000 and 9,000 lb. per acre. The analysis of soils have not, however, revealed any increase in either organic matter or nitrogen status of soils, with increased application of green manure.

In the scheme for study of different control measures against hairy caterpillar on cardamom (*Eupterote canaraica*) in Coorg, the pest was not reported active during the quarter under report in a survey undertaken in Somwarpet and Napoklu Taluks. In the life-history studies

conducted at Kudige it has been observed, that there is marked variation in the morphological characters of moths (variation in colour and pattern of markings on bodies) emerging in laboratory cultures and studies are in progress to ascertain whether these may be due to existence of different species or subspecies in *E. canaraica* or due to climatological and/or nutritional factors. It may be mentioned herein that other species of Eupterota, namely *E. fabia* and *E. undata*, have been recorded in South India.

In the scheme for cotton physiological research at Dharwar and Gadag, sowings of NP and NPK experiments were over. Soil samples were taken up for analysis in the plots conducive to bad opening of cotton bolls and in the normal yielding areas.

In the Division of Agronomy at the College of Agriculture, Dharwar, many field experiments were completed pertaining to cultural and manurial schedules of various crops, during the quarter under report. As regards groundnut crop (*Arachis hypogæa*), yields of pods are found increased by about 45% by the application of 10 lb. nitrogen and 5 lb. of P_2O_5 per acre; while application of K_2O appears to reduce the yields. Frequent interculturings are found beneficial in increasing the pod yields.

In field experiments with Jowar, results of scattered trials have revealed that application of 20–40 lb. nitrogen along with 20 lb. each of P_2O_5 and K_2O could increase the yields in balck soils while in red soils, application of 60 lb. N and 30 lb. K_2O could increse the grain yields by about 20%. Placement of fertiliser studies show, that drilling of fertiliser in the same line and drilling both ways could bring increased yields of *kharif* Jowar. As regards fodder Jowar, variety *Nandyal* sown at 20 lb. per acre and fertilised with 40 lb. N and 20 lb. P_2O_5 has been found to give yields up to 15,000 lb. per acre, nearly double than obtained with variety *Nilwa* under similar treatments.

In cultural trials with cotton, sowing of *Laxmi* cotton in the second week of June was found to increase the yields to the extent of 45% as compared to the crop sown late in July in red soil. Sowing a mixture of cotton and groundnut (1 : 1) was found to give 30% more cash income than when cropped with cotton alone. Results of scattered fertiliser trials have revealed that application of 20 lb. each of N and P_2O_5 to the cotton crop increases the yield to the extent of about 39% over control.

—(D. V. M.)

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